

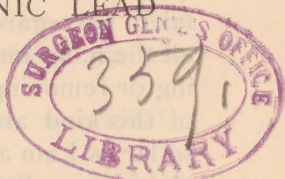
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CLINICAL NOTES ON CHRONIC LEAD POISONING.

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THREE years ago, I reported to the American Neurological Association a series of eight cases of chronic lead poisoning, not presenting the signs usually considered characteristic of that disease, and therefore likely to escape detection if the indications set down in the text-books were strictly followed.

Since that time, I have continued these researches with the valuable aid of Prof. E. S. Wood, of the Medical College, and of Mr. A. M. Comey,¹ Assistant in the Chemical Laboratory of Harvard University at Cambridge, and have become more convinced than ever that chronic lead poisoning, especially from drinking water, is far more common than is usually believed.

It was my intention to select the cases for this new series almost at random, though giving preference, for therapeutic reasons, to those which exhibited the symptoms already shown to be significant. I hoped in this way both to test the frequency of occurrence of lead in the urine in cases not presenting the usual lead symptoms, or even, necessarily, any symptoms, and also to see whether any new symptoms or types of disease could be found to be characteristic.

I am well aware that cases are to be found scattered through the vast and unwieldy literature of lead poisoning,

¹ Most of the analyses for this series were done by Mr. Comey, to whose skill and patience I am greatly indebted.

similar to most of those recorded in this paper, but I report them, first, because I believe it is not sufficiently recognized that no obscure case of functional or organic nervous disease should be thought fully investigated until lead has been sought for, and further, because I think it can be shown that lead is found with such relative frequency in certain forms of chronic myelitis that it may fairly be regarded as an important cause of that disease, all the more important because of the possibility of avoiding or removing it. Although a number of isolated cases of this kind are on record, yet no author of a text-book, so far as I am aware, speaks of lead as a frequent cause of chronic myelitis, except Dr. S. G. Webber,¹ in his recent manual.

It is especially desirable to know what symptoms should arouse even a suspicion of lead poisoning, because the analysis of the urine is so difficult that it can never be undertaken as a simple matter of routine, and we are generally forced to rely on the clinical evidence alone.

Finally, the investigation seems to make it clear that lead may be occasionally present in the tissues in sufficient quantity to make its detection in the urine possible, and yet exert no markedly injurious effect upon the health.

Thus, in a case of neuritis, involving both the lumbar and sacral plexus, and due to the pressure of cancerous growths, lead was twice found in relatively considerable quantity, although at the time the patient showed no sign of general cachexia or ill-health, nor any symptoms which our present knowledge would enable us to associate with lead poisoning.

The discovery of minute quantities of lead in the system, of course, does not justify us in laying to its score all the ills from which the patient may suffer, or in expecting necessarily to cure, by removing the poison, even the whole number of those symptoms for which the lead was directly or indirectly responsible. The best that we can hope for, at present, is to be able to say of lead, as we can

¹ "Nervous Diseases," Boston, 1885.

now say of syphilis; first, that it sometimes sets up morbid changes which its elimination will cure; second, that by diminishing the resisting power of the tissues, it is the indirect cause of many trains of symptoms, a portion of which may disappear, or partly disappear, on its elimination.

The method of analysis of the urine, used in the former experiments and described in connection with the cases already reported, has been slightly modified for the present series.

In the first set, the lead was thrown down as an iodide, which was recognized by its yellow color.

This had the objection, the practical bearings of which were discussed in the paper alluded to, that bismuth, if present, would give almost the same reaction with lead. In the new series, therefore, Mr. Comey, at Prof. Wood's suggestion, has used the additional precaution of redissolving in hot water the iodides of lead and of potassium, after making the color test, and then filtering and precipitating the lead with dilute sulphuric acid, and allowing the precipitate, with the supernatant liquid, to stand for twenty-four hours in a test-tube wiped perfectly free from lint and other impurities. On then gently twirling the tube between the fingers, any sulphate of lead which is present rises in the form of a characteristic spiral cloud.

As regards the accuracy of the process, Mr. Comey says: "I tried three normal samples and found no trace of lead. I then added 0.005 lead acetate to the litre, that is one part in 200,000. In two instances, I found a slight trace of lead; in the third, it was doubtful if any was there. I then tried 0.020 to the litre, *i. e.*, one part in 50,000, and found lead far stronger than in any urine I have examined."

The symptoms of most frequent occurrence in the eight cases reported in the former paper were: muscular tremor; a sense of numbness and prickling in the legs or in all four extremities, with impairment of the strength; exaggeration of the knee-jerk, and other signs of diffused chronic myelitis. In one case, there was extreme and

progressive anæmia, with almost universal paræsthesia and gradually increasing paresis, especially of the legs, and eventually death. In another interesting case, in which the urine was twice found to contain lead, there were various diffused, bilateral cerebral symptoms, attacks of dizziness, headache, remittent "numbness," *involving all four extremities*; twitching of the muscles, or parts of muscles, on both sides of the body, but especially the left arm and leg, and steady improvement attended the use of small doses of iodide. The diagnosis was complicated by the fact that the patient had had a chancre, without secondary symptoms, ten or eleven years before, and I will here take occasion to remark that the early symptoms of cerebral syphilis and those of the cerebral cases of lead-poisoning are sometimes strikingly similar.

The whole number of new analyses of the urine on which I have now to report is forty-eight, and in twenty-five of them lead was found. Only those cases are included in which blue line on the gums, paralysis of the extensors of the fingers, and characteristic colic were absent, and, it might be added, with one or two exceptions only those whose occupation would not have been thought to expose them to poisoning from lead.

Of the twenty-five cases in which lead was found, signs of diffused myelitis of one or another type were present in twelve. These twelve cases may be divided between those where the lead—if it was in fact the efficient cause—had excited typical groups of symptoms, mainly referable to localized lesions; and those where the symptoms were relatively diffused and irregular.

The former group embraces four cases, with symptoms pointing either to *multiple cerebro-spinal sclerosis*, or to *spastic paraplegia*, such as is usually considered due to primary sclerosis of the lateral motor tracts.

The spinal cases in which the urine was examined for lead and none was found¹ are eleven in number, and com-

¹ It is worth remarking that a single negative examination of the urine does not prove that lead is not present in harmful quantities. In two of my cases,

prise four typical cases of progressive muscular atrophy, and two of locomotor ataxia—the only cases of these kinds that were examined at all; one case of subacute, symmetrical poliomyelitis of the adult; two cases of spastic paraplegia; one with symptoms of multiple sclerosis, but beginning in early youth; and one obscure and irregular case of diffused cerebro-spinal disease.

The four cases of sclerosis in which lead was found, and yet which presented few, if any, signs of the generalized action of the poison, were, in brief, as follows:

CASE I.—Male patient, married, 30 years of age, farmer. Presents symptoms of chronic malaria and has a large spleen; otherwise, general health excellent. During past two years, increasing weakness and awkwardness in use of all four limbs; feet and hands often numb; pains in various parts of body; loss of sexual desire, following increase; spastic gait, especially right, and exaggeration of deep reflexes; local anæsthesia in various parts of body, especially on right side; vision normal, fundus oculi normal; no history or sign of syphilis; *very small amount of lead in urine* (Prof. Wood). Occupation does not bring him into contact with lead. Drinks fresh pond water (Cambridge, Mass.), not drawn through lead-pipe. Until within a year, however, drank water from a deep well. Does not know what kind of pipe was used, but remembers that another person who drank from the same well had symptoms said to have been traced to lead. Marked improvement at first under treatment by iodide of potash, quinine, galvanism, and cauterization; *later*, relapse, cystitis, attacks of faintness, mental confusion, and drowsiness.

CASE II.—Male patient, bootmaker, married, 50 years of age. Spastic gait; exaggeration of the deep reflexes; ataxia of the hands; and permanent contraction of both pupils. *Lead was found twice in the urine*, at intervals of ten months, one examination being made by Prof. Wood, and one by Mr. Comey. No other cause whatever could be assigned for his disease.

CASE III.—Male patient, painter, married, 46 years of age. Spastic gait, with exaggeration of the deep reflexes; sudden attacks of dizziness; increased frequency of micturition; *small trace of lead in the urine*. No other cause could be assigned.

CASE IV.—Male patient, about 35 years of age. Symptoms limited to spastic gait, exaggeration of knee-jerk, and ankle clonus. No pain or disorders of sensibility; no paralysis or atrophy or disorders of micturition. Onset gradual, and dates back ten years;

it was found only twice out of three trials. See in this connection a paper by C. B. Penrose, Phila. Med. News, Sept. 14th, 1885.

considerable amount of lead in urine (Prof. Wood). At time of onset was living on a farm and drank water drawn with wooden bucket; not long previous to this, however, he lived on a farm where he drank a great deal of water which came half a mile through a lead-pipe; gradual improvement, he thinks, during several months of treatment by iodide of potash, etc.; then lost sight of. No cause other than lead could be assigned for the disease, except a fall from his horse, some time before the symptoms set in.

In the absence of lead cachexia, marked debility, muscular tremor, or recovery under iodide of potash, there must remain a doubt, which can only be settled by many observations, whether the symptoms in such cases as these are really due to lead, and if so, what the nature of the relationship may be. It is, however, to be remembered that a similar uncertainty attaches to the nature of the connection between syphilis and locomotor ataxia; and yet, nevertheless, the fact that there is some connection is almost beyond a question.

In the remaining cases, although the spinal symptoms predominate, a wider and more diffuse action of the poison is indicated, and in most of them more or less signs of disturbance of the general nutrition were present. The first case approaches closely those of the former group.

CASE V.—Male patient, sawyer, married, 49 years of age; lives at Somerville, Mass. Sense of weakness and pain in back for ten or twelve years, but worse during the past two years, without apparent cause; sense of fatigue in legs and thighs on slight exertion; spastic gait, general feeling of drowsiness and languor; cramps in calves of legs; feeling of soreness along both groins and in the back; arms and hands rather weak; no alteration of sensibility, subjective or objective; face pale; pupils large and mobile; heart-sounds weak, but no murmurs; sleeps fairly at night, but not so soundly as formerly; chancre twelve years ago, with doubtful secondary symptoms; exaggerated knee-jerk, ankle clonus; and some exaggeration of deep reflexes in upper extremities; strong trace of lead found in the urine; considerable quantity also in drinking-water.

CASE VI.—Male patient, married, 53 years old; lives in Salem St., Boston.

Sense of numbness and prickling in the hands and arms, alternating with sense of heat and cold; sometimes slight dragging of left leg and foot in walking. This feeling of numbness is most

marked in forefinger of left hand, which is also abnormally sensitive to heat, and is the seat of an unnatural sensation when any object is grasped; fingers twitch, and feel swelled toward night; two middle toes of left foot sometimes feel numb; is easily fatigued, and short of breath on exertion; all these symptoms worse towards night time; pulse full, 72, not tense; slight trembling of muscles of neck, and marked trembling of hands and arms; knee-jerk exaggerated both sides, especially left; is rather thin, but a sufficiently healthy looking man; no history or sign of syphilis; small amount of lead found in urine; has used hair dye for a number of years, but the coloring matter in this proves on examination to be made of nitrate of silver.

CASE VII.—Female patient, married, 45 years old, lives in Milford.

Debility; diplopia; dizziness; slightly staggering gait; headache, especially on right side; backache; right pupil slightly smaller than left, and reacts less to light; small atrophy of optic disc; exaggeration of knee-jerk and ankle clonus, especially right; lead found in urine.

These symptoms are attributed by patient to a severe injury received nine years ago. The case is reported because of the possible significance of the exaggerated knee-jerk as pointing to lead, the cerebral disease being hardly sufficient to explain them.

CASE VIII.—The following case is remarkably interesting, both on account of the character of the symptoms referable to disease of the spinal cord, and on account of the improvement under treatment. It will be published elsewhere at length, but is here given in brief outline.

Female patient, single, 27 years old. Health good until about three years ago, since when has suffered from progressive weakness in legs; later also in arms; aches and pains about the joints; marked impairment of the cutaneous sensibility, and marked sense of numbness; some muscular atrophy, especially noticeable in the ulnar distribution of both arms; blurring of vision with considerable impairment of vision, left; almost entire loss of muscular sense in the hands and arms, and a high degree of ataxia of movement; marked exaggeration of knee-jerk, and some increase of the deep reflexes in the upper extremities. It was found that the patient drank during part of the year from a very old well, the water of which was found to contain offensive organic matter, and a large quantity of lead. The urine also contained a considerable quantity of lead. The only other possible cause for the symptoms lay in the fact that one or two members of the family in a previous generation were said to have suffered in a somewhat similar manner. The patient was put on treatment of iodide of potassium, and, although she had been steadily losing ground previously, she gained steadily, and nine months later was reported

by her sister as being able to use her hands almost as well as ever.¹

CASE IX.—Male patient, about 35 years old; not exposed by his occupation to lead. General feebleness for fifteen years; muscular weakness and sense of prickling and numbness in legs for the past few months, and some objective loss of sensibility; same symptoms in less degree in arms and hands; twitching and cramps in legs; history of malarial fever; lead found in considerable quantity in urine; marked improvement under treatment by potassic iodide.

CASE X.—Male patient, married, about 35 years old. Muscular tremor; exaggeration of knee-jerk; no ankle clonus; several attacks of numbness and prickling of tongue and mucous membrane of the mouth and hand on left side; later, slight attack of aphasia; no history or sign of syphilis; urine examined twice for lead; first time a considerable quantity found, second time none found.

CASE XI.—Male patient. Loss of power in the fingers and thumb of the right hand, at first remittent and associated with temporary attacks of numbness and prickling, then permanent. Later, temporary loss of vision in right eye, and two weeks later, a similar attack. Tenderness on pressure of toes of right foot; slight aphasia, and slight difficulty in articulation; no sign or history of syphilis; small amount of lead found in urine. *Works in a rubber factory and handles rubber in the making of which litharge is used.*

The following case was not included in the list, because the urine had not yet been examined. It is, however, recorded here, because the signs of lead poisoning are unequivocal. The interest of the case is the greater that this patient, like the last, worked in a rubber factory. This occupation has furnished to me, and to several of my colleagues, a number of cases of serious impairment of the health, though not all presenting the same symptoms. The room-mate of the patient whose case is about to be reported, suffers from symptoms closely similar to his, and was told by the physician whom he saw at the Massachusetts General Hospital that he was under the influence of some poison, my informant did not remember what. Litharge is largely employed in manufacturing articles of rubber, and although not used in the factory from

¹ Two cases of ataxia, more or less resembling that reported here, are quoted in the Monograph of Renaut ("De L'Intoxication Saturnine Chronique," Paris, 1875), from observations by Raymond and Vulpian.

which these last-mentioned patients came, their work consisted in grinding up articles made of rubber, and probably exposed them to dust containing particles of lead. I have heard from another source the general statement that the health of the operatives at this factory was not good.

CASE XII.—Male patient. Severe abdominal pains for the last four months; constipation and some colic; tenderness on pressure, in the abdomen; pain also in back; fatigue in walking; insomnia, due, he thinks, to pain; complexion and conjunctiva slightly yellowish; exaggeration of knee jerk, both sides, and traces of ankle clonus; marked blue line on gums.

This case, with its symptoms of typical lead-poisoning blue line, and colic or abdominal neuralgia, and at the same time with its signs of myelitis, the exaggerated knee-jerk, and trace of ankle clonus, seems to strengthen the belief that the cases where spastic gait and exaggerated knee-jerk formed the main symptoms, really owed their disease to the lead which was found in the urine. In fact, an abnormally active knee-jerk has come to be strongly associated in my mind, perhaps too strongly, with a suspicion of lead-poisoning.

In looking over the recent entries in the hospital records, I find one case with these notes: "spastic paraplegia; numbness of hands and feet; exaggerated knee-jerk; works in a rubber factory." The urine has not yet been examined for lead, but I shall seek an early opportunity to have this done, with some degree of confidence that the result will be affirmative.

CASE XIII.—Male patient, single, about 35 years old. Sense of fatigue in legs, felt mainly in the calves, so that he gets extremely weary at his work; no impairment of gross strength; sense of numbness and coldness in thighs, especially over anterior surface; calves of legs feel stiff and numb in the morning; has pain running down them as far as the heel, yet is not conscious of any stiffness of the legs in walking; remains of an acute cystitis for which he was treated recently at the City Hospital; tremor of hands and muscles of face in talking (this symptom, he says, he has had ever since boyhood, but for the past few months it has been better than ever before; a year ago it troubled him so much that he was sometimes thought to be drunk, and could scarcely sign his name distinctly); no sign or history of syphilis; physical

examination shows nothing abnormal except exaggerated knee-jerk; urine contains considerable lead. A possible source of the lead was a former habit of holding a piece of lead in his mouth.

CASE XIV.—Male patient; tremor of hands; constipation; “rheumatic” pains in arms and shoulders; drinking-water comes from a wooden tank, but urine contains a small amount of lead.

CASE XV.—Male patient; married; switch-tender, and much exposed to bad weather; habits of life unexceptionable in every respect. Has been under observation a number of years at the Massachusetts General Hospital, presenting the following symptoms: Constant aching-pains in back and legs, called “rheumatic;” stiffness and weakness of legs; fine tremor of hands; no disorders of micturition. The urine has been examined three times, with the result that lead was found in considerable quantity the first and last times, and was not found the second time. For a long period, under the use of potassic iodide, cauterization and galvanization of the back, there was marked improvement, but of late he has relapsed.

As I have already said, instances of paraplegia from lead are to be found here and there in the literature of lead-poisoning, though they appear to have attracted but little attention, as a rule. The report to the Am. Med. Assoc., in 1852, by a committee, of which Dr. Horatio Adams, of Waltham, was chairman, refers to several cases in which symptoms like those which I have repeatedly found had been described by their correspondents.

One case, which is narrated by the patient himself in full detail, is that of a prominent citizen of Boston, who suffered from symptoms closely resembling those of typical amyotrophic lateral sclerosis, with contractures to such a degree that he was almost confined to his chair, and yet greatly improved, temporarily at least, after discontinuing his drinking-water and taking heroic doses of strychnia. The urine, in this case, was not analyzed, but the patient says of his drinking-water “that that for cooking passed through 140 feet of lead-pipe to the kitchen pump, and that he had used it for nine years; that, for some months past, he had made his breakfast of crushed wheat, which, after soaking in water all night, was put on to boil the first thing in the morning, and probably the water which lay in the pipes all night was used for this purpose. The drinking-water chiefly used was brought through 140 feet of lead-pipe from another well to another pump.

“On being tested with sulphuretted hydrogen, that of the kitchen pump became very dark, and, after standing till the next day, looked like ink and water; that from the other pump was colored, but less highly.”

Fine muscular tremor was noted in several of the spinal cases, and in nine others, and was usually associated with debility or other characteristic symptoms. This muscular tremor is not to be confounded with the coarse trembling seen in later stages of lead paralysis; and, although by no means a new symptom, it is noteworthy as being of a great diagnostic significance even when unattended by any other signs of lead-poisoning whatever, and although continuing for years without being followed by paralysis or any other serious symptom, and even when so slight as scarcely to attract the patient's attention.

Such was the chief symptom, though, in each instance, associated with more or less general debility, in the following cases:

CASE XVI.—Female patient, somewhat past middle life. Debility; very fine tremor of hands; no other symptoms; lead found both in urine and in drinking-water.

CASE XVII.—Male patient, a business man in good circumstances. Debility; fine muscular tremor; small amount of lead found in urine.

CASE XVIII.—Male patient, 54 years old, weaver in a mill at Maynard, Mass.

Good habits in every respect, and excellent health until about three years ago, and even up to the present moment in most respects. Three years ago, he first noticed general weakness and a tremor of hands; for past eighteen months has suffered greatly from a feeling of soreness at the vertex and from attacks which he calls "rush of blood," and describes as a sort of aura spreading over the body and head; also from "buzzing" noises in the head. Sleeps well; no colic; no mental symptoms; no blue line.

The face is reddish and rather congested, and nothing in his appearance suggests the lead-cachexia, except the slight trembling of fingers, lips, and tongue.

On close and repeated inquiry, it was learned that the drinking-water was conducted to his kitchen pump from a well twenty-five feet away, through a two-inch lead pipe, and that the end of the pipe rested permanently in the well. Several other families were supplied from the same well.

The water was analyzed, and found to contain lead. The urine was analyzed three times, the result being twice affirmative of the presence of lead, and once, the last time, negative.

The patient had lived ten years in the same house. He had been in the habit of drinking a goblet of water every night, but

not, it is interesting to note, from the first pumping. The kettle for cooking had always been filled at night.

A sense of "*prickling and numbness*" in the extremities, usually intermittent or remittent, and worse at night, was observed a number of times, but I do not consider it so characteristic a symptom as the tremor, because it occurs under so many different conditions, of the nature of neurasthenia and general debility.

A similar condition, but associated with typical hemianæsthesia, and sometimes hemiparesis, has several times been reported as due to lead poisoning.¹ Recent researches, both at home and abroad, have, however, shown that this symptom, besides being met with in hysteria and as a result of lesions in the posterior limb of the internal capsule, is readily brought on by a variety of causes which tax the nervous system severely and suddenly, such as epileptic attacks, concussion accidents, and the like, and it is probable that its relation to lead-poisoning likewise is of this general character, and not the sign of a localized organic lesion.

It is quite possible that the same may be said of the *exaggerated knee-jerk*, which was so frequently observed in my cases. I have but little doubt that spastic paraplegia of organic origin, of which this is a characteristic sign, is often due to lead-poisoning; but in other cases, the lead, besides the organic lesions which it causes, seems to induce a sort of neurasthenic condition in which, as is well known, the exaggerated knee-jerk, without ankle clonus, is often met with. Such is at least a possible explanation of this symptom as it occurs in the following case:

CASE XIX.—Printer, 25 years of age; well until four years ago, since when he has suffered from increasing nervousness and sleeplessness; tremor of hands and lips; no excess of any kind, except perhaps tobacco; no sign or history of syphilis; no headache, colic, or constipation; no paralysis of sensation or motion; knee-jerk very lively, especially right; no ankle clonus; frequency of micturition; large amount of lead in urine; on a second examination, knee-jerk less marked.

¹ Raymond, quoted by Renant: *De l'Intoxication Saturnine chronique*, 1875. Hanot et Mathieu, *Arch. Gén. de Méd.*, 1878.

Another point is worthy of note, namely, that an inequality in the knee-jerk of the two sides also points to organic disease, either in the cord or brain or peripheral organs. Besides the cases which I have reported, I have notes of two cases of epilepsy,¹ beginning rather late in life, where lead was found; and a case of mixed intracranial and spinal disease, where the symptoms seemed to be mainly due to syphilis. One or two other observations also are not reported for want of sufficient notes.

CASE XX.—The last case that I shall refer to is that of a gentleman, naturally of robust health and free from neurotic tendencies, who has suffered for about a year from a severe form of clonic torticollis, associated with considerable depression of spirits and for a number of years from muscular tremor of the hands.

Analysis of the urine and of his drinking-water showed the presence of lead in both. The drinking-water, which, I believe, was only used for a part of his supply, came from a cistern through a lead pipe, the end of which stood in the water.

The pipe was removed, to the great scorn of the plumber, and four inches of the end was sent to me for inspection. No corrosion could be detected, and the question arises whether, under these circumstances, sufficient lead could have been dissolved to exert a poisonous effect. The answer can probably be given in the affirmative. In the first place, lead is always dissolved by water containing air, acid, or organic matter in solution, unless it is protected by a coating of insoluble salts, mainly sulphates and carbonates. The very deposition of these salts, however, as is pointed out in a recent pamphlet by Hamon,² is probably an indication of the galvanic action along the walls of the pipe, since otherwise the salts would be deposited, by the action of gravitation, on the depending portions of the tube, instead of uniformly on its surface.

¹ One of these two patients with epileptic attacks has just reported that on the second examination of urine, which has just been made, a considerable amount of lead was found. There is nothing in his appearance to suggest lead-poisoning except a look of slight debility; even tremor of the hands is absent. The importance of the discovery is obvious, the more so that isolated cases of the kind have been reported.

² "Etude sur les Eaux Potables et le Plomb." Paris, 1884.

It is probable that this galvanic action sets free lead in a soluble form. It has also been shown to be probable that the same galvanic action goes on, to greater or less degree, beneath the protective coating, so that sooner or later even cold-water pipes are sometimes eaten away.

The interesting paper on lead-poisoning in the Massachusetts State Board of Health report for 1871, by Prof. William R. Nichols, also contains a suggestion which is interesting in this connection. He says (page 33): "In all water, hard and soft, there appears to be formed at first an oxide (or hydrate), and this also is more soluble than the oxy-carbonate. If lead be partially submerged in water, there will always be found on it, after some days, *at the surface of the liquid*, yellowish-white crystals of hydrate of lead, along with the crystals of oxy-carbonate."

I have italicized the words "*at the surface of the liquid*" to call attention to the possible increase of danger where lead-pipe is partially submerged in a reservoir, the level of the contents of which is rising and falling. Whether such was the case here I cannot say. It is also well known that the galvanic action set up by lead-pipes which are soldered to stop-cocks or to iron mains is a fruitful cause of active corrosive action.

In all the cases that I have reported in this paper, the source of poison was unknown, except in those where it was specified. Did it come from the drinking-water, which in almost every cause was conveyed through lead-pipes? Certainly, the contrary cannot be asserted with confidence.

The last report of the Massachusetts State Board of Health, 1886, says that but few cases have been reported since the large number contained in the report for 1871. May this not mean that, owing to the increased precautions suggested by a better knowledge of the subject, the more extreme cases of lead-poisoning have been avoided, but not those characterized by less violent, but hardly less serious symptoms? In the report of 1871, Prof. Nichols says (page 37): "I feel justified in asserting that Cochituate water which has passed through lead-pipes is never ab-

solutely free from lead." In the pamphlet by Hamon, to which I have already referred, an account is given of some experiments made by Gautier and reported to the Academy of Medicine at Paris, in 1881, in which he found that the water of the Dhuys, after standing ten hours in a new lead-pipe, contained 0.0001 of lead to the litre. This is not far from one-hundredth of a grain to the gallon; and in the report made to the Am. Med. Assoc., in 1852, by Dr. Adams, this proportion of lead is declared to have several times proved injurious. A simple calculation shows, to be sure, that a person drinking daily one quart of water containing this proportion of lead would take only about one grain of lead in the course of a year—a quantity which seems absurdly small. But, while we are at liberty to doubt the accuracy of the chemical estimate, we are not at liberty to set aside the opinion that minute quantities of lead taken into the body little by little may, after a time, give rise to serious effects.

It is well known that, in all except the newest of our dwelling-houses, lead-pipe forms the connection between the street-mains and the houses, and it is difficult to find a satisfactory substitute. Galvanized iron, brass, and block tin, all have their objections, although the remark of a witty Frenchman may be put on record that "in the use of brass for domestic purposes the anxiety felt is out of proportion to the danger, while in the use of lead the danger is out of proportion to the anxiety."

The best substitute for lead is probably lead carefully lined with block tin, or rather superposed upon tin. Even this, however, is not absolutely free from danger, both because the coating may give here and there, and because of the danger of galvanic action in the joints. Furthermore, it would be out of the question to introduce this expensive substitute into the older portions of the city. In the face of these facts the question arises, what next can we do to secure a safe drinking supply? The answer would seem to be the one which has so often been given: first, that the water should be allowed to run from the pipes a sufficient length of time before it is used; and then

that cold-water pipes, used for drinking purposes, should not be allowed to run in the immediate neighborhood of the hot water service.

The next question is, how long must the water run in the morning in order to free the pipes of the contents which have accumulated during the night? A piece of lead pipe four inches long and an inch and one-fourth in diameter contains about two ounces of water, so that something over two gallons would be contained in fifty feet of pipe. It is probable that a good deal more water than this should be allowed to run off if we wish to be sure that that which remains is absolutely free from contamination.

In an interesting communication, by Dr. W. B. Thomas, in the *London Med. Press and Circular* of January 27th, 1886, a series of cases are reported of lead-poisoning from drinking water in the town of Sheffield, England. In relating them, the writer says that in each case the patients asserted that they had allowed the water to run five or ten minutes before using. It appeared evident to Dr. Thomas that the number of these cases had materially increased within the past few years, and, in his opinion, this increase was due to the fact that the water had recently contained more free acid than previously. In this connection, it is to be borne in mind that the solvent action of the water in our large cities, and still more in the country towns, is liable to be at any time similarly increased, either by the introduction of new sources of supply, or by the temporary increase in the organic impurities washed in by large rain-falls, or due to the contamination from factory towns.

The greater part of the cases reported in this paper are those of patients living in the country. A few, however, were from Boston and the neighboring towns.

I intend, as soon as possible, to carry these investigations further, especially with regard to the cases of this latter group. May we not also hope that something still further can be done for the protection of workmen engaged in occupations where the use of lead exposes them to life-long disablement, or that, at least, some way should

be found to give them a more intelligible warning than they now receive of the danger to which they will be liable.¹

¹ I desire to express my obligation to my colleague at the Mass. Gen. Hosp. Dr. G. L. Walton, for allowing me the use of his notes of several of the cases reported. I wish to say in addition, that although I have given the cases in brief outline only, the patients had been examined carefully for other causes of disease, especially chronic nephritis and syphilis.

